Volume 9 June, 1923 *Number 6*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of Excavating Machinery

Power Shovels, Ditchers, Trenching Machinery, Drag-Line Excavators, Back Fillers, Dredges

Lubrication of Concrete Mixing Machinery

Including Engines and Motors

PUBLISHED MONTHLY BY
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Vol. IX June, 1923 No. 6

Change of Address: In reporting change of address kindly give both old and new addresses.

Lubrication of Excavating Machinery

EXCAVATING machinery as used by the construction engineer and contractor is subject to probably as severe service and operates under as difficult and injurious conditions as any equipment we will normally have to deal with. Exposure to the weather and frequent contact with mud, dust and such abrasive and corrosive materials as ashes, cinders and ore, etc. subject the working parts of the average power shovel, dragline excavator or dredge to a rate of depreciation that is oftentimes far above normal. To counteract the injurious effects of such exposure, machinery of this type is rigid in design and is constructed to withstand acids, alkalis, abrasion and corrosion to the highest extent. It stands to reason, however, that regardless of mechanical features or the chemical nature of the metals used, wear will occur relatively rapidly unless a protective element in the form of a lubricant is effectively applied to all machinery. Therefore, lubrication in the field of construction engineering is a paramount feature if we desire our cylinders and bearings to resist scoring in event of the entry of abrasive particles of foreign matter; our gears to operate properly without abnormal wear in the presence of acid fumes or dust; and our wire ropes and chains to function safely day after day without the possibility of broken or rusted strands, or links.

Excavating Machinery Classified

Under this general classification there will normally be included power shovels, ditching machines, dragline excavators, trenching and backfilling equipment and dredges of various types. The digging, handling and disposal of earth, gravel, sand, ore and other solid and semi-solid materials preparatory to construction work are perhaps the most important factors with which the contractor has to contend. They have led to the development of various machines as mentioned above, which are probably the most potential labor and time saving of any equipment in the field of engineering.

Although they are all designed to broadly perform the same function,—the handling of excavation material,—there are many special types in service, adaptable for particular classes of work. For example, the power shovel works within a relatively limited area, handling its material by means of a shovel, dipper or grab bucket. On the other hand the dragline excavator is adapted to a wider area and operates by means of a boom and scraper bucket, the latter being dragged through the material and filled during this process. Again, trenching machines serve to excavate a relatively narrow ditch of considerable depth, such as would be

used for the laying of public utility piping systems.

Power Shovels

Power shovels are usually built along two designs according to the class of service they are to be used for, and are customarily known as the revolving and the railroad types. The principles of operation of both are similar, although the former is intended for lighter work such as would be encountered on building excavations, and stripping jobs in mining, etc.; the latter on the other hand is adapted to more severe service such as in railroad construction, and stone quarry service. In general design a power shovel consists of a revolving frame or turntable which carries the boom or shovel arm, the engines and other operating mechanism. A suitable carrying frame or truck which may be equipped with standard railroad wheels or mounted on a truck fitted with broad traction wheels of the trackless type, or a caterpillar tractor device may also be installed. In practically every case the machine is self-propelling. The revolving frame is carried on roller bearings or cone rollers which travel on a suitable swinging gear casting securely attached to the truck frame.

Hoisting engines in use on the various types of power shovels may be either of the steam driven vertical or the horizontal type, receiving their steam from a locomotive type or upright boiler located on the turntable. Both engines and boiler are free to swing with the turntable, as has been mentioned above, being mounted on rigid bases and securely bolted to the main revolving casting so that vibration becomes relatively negligible. Gasoline, kerosene and electric power driven engines may be used to supplement the steam boiler and steam engines if desired on certain types of shovels, although this is not common practice. There are, in general, three engines required for the efficient operation of a power shovel, i.e., a hoisting engine which controls the rise and fall of the shovel or dipper; a swing engine for the revolving of the turn table; and a thrusting engine to operate the shovel in the process of digging. While many builders install all these engines on the turntable itself, there are some which locate the shovel thrusting engine on the boom instead.

Ditching and Trenching Machines

Although ditching machines are designed to operate in a somewhat similar manner to power shovels, and are built along the same general principles, their actual function of linear excavation places them more nearly in the category of trenching machines. Ditching machines are most commonly found in railroad service, where they are used to build adequate drainage ditches of varying depth, adjacent to the roadbed and track. They are generally operated as self-propelled with flanged wheels traveling either on the main track itself or on portable sections of track laid on a train of flat cars.

The trenching machine, on the other hand, is designed to excavate a trench by the application of an endless-chain bucket device or a digging wheel. This machine is especially adaptable to street work where rapidity in digging and disposal of earth preparatory to the laying of water, sewer or gas mains is essential.

Whatever the type of trench excavating attachment, the general construction of such machines is similar, and consists of suitable operating mechanism such as steam boiler, steam or internal combustion engines, and gearing mounted on a rigid truck body. According to the design, it may be built with all four wheels of the caterpillar tractor type, or may use these only as the drivers, having broad rim plain wheels at the opposite end. In operation such a machine straddles the trench line and advances accordingly as the excavator does its work. This latter, in the ladder or endless chain bucket type of machine consists of a series of buckets attached to a continuous elevator or endless chain, and working in conjunction with a disposal conveyor. Thus as the machine advances, the buckets continually dig into the earth, are filled, carried upward, emptied and their contents disposed of.

The wheel type of excavator carries an internal gear of varying size, equipped with buckets or digging blades set equidistant on the rim, and driven by a suitable pinion and chain connection from an engine on the truck. As the machine advances and the wheel revolves,

Fig. 1.—Type of Gas Shovel which is exceptionally mobile and adaptable to cut work. This machine can be changed readily from shovel to a pile driver or back filler. *Courtesy of Pawling & Harnischfeger Co.*

Fig. 2.—Bucket or multipedal type of trenching machine. This is a gasoline engine operated machine especially built for trenching in hard stony ground. *Courtesy of Austin Machinery Corporation*

Fig. 3.—Drag Line excavator equipped with a 60-foot boom and 2½ cubic yard bucket. *Courtesy of Austin Machinery Corporation*

the blades dig into the earth, which is carried up and dropped onto a right angular disposal conveyor to be spread along the bank of the trench.

In certain designs the steam power shovel can be so manipulated as to serve as a trenching machine, by using a reversed bucket or hoe, and dragging the material from the trench. This is dragging through the material, after which it is raised and swung to the point of disposal.

Back-Filling Equipment

For the re-handling of excavated materia such as is necessary when trenches or ditche are to be filled in, it is customary to employ back-filling machine of some form. Usually

Courtesy of Keystone Driller Co.

Fig. 4.—Skimmer Type Scoop Shovel as used for surface excavation. This illustration shows clearly the hard rough service to which such machines are usually subjected.

an economical conversion when but one machine is available and where it must be used for other than wide area excavation.

Dragline Excavators

Where excavation consists of rough materials, and skimming or scraping is chiefly to be done, it is often desirable to use an adaptation of the power shovel known as a dragline excavator for this purpose. In construction, such a machine is much similar to the power shovel with the power plant, boom and controlling mechanisms mounted on a revolving turntable. The boom is usually longer, however, than the shovel boom and carries a ditcher or scraper bucket adequately controlled by draglines or cables. In operation the bucket is raised to the required height by the hoisting engine, swung over the area to be excavated and dropped or thrown (according to the skill of the operator) to the desired location. Then by taking up on the dragline the bucket is filled by

back-filler is built somewhat on the order of a small dragline excavator, being fitted with a scoop or scraper controlled by a boom, dragline and winch. Thus the material is dragged from the dump back into the trench as desired. Back fillers may be equipped throughout with propelling mechanisms of the creeper traction type, or a combination of broad rim wheels and tractors. On the other hand, power shovels can be readily adapted to this purpose, or a drag scraper attached to and operated by a locomotive crane in any case where special machinery is not available.

Dredges

Although dredges are not usually involved in excavation and materials handling operations in many parts of the world, they are nevertheless most necessary equipment wherever land reclamation, canal work, drainage, ditching in swampy land, or the excavation or filling of river beds or embankments, is to be done.

Essentially there are three types of dredges, viz.: the dipper type which is built much on the order of the power shovel; the placer dredge which is frequently used in mining operations; and the hydraulic or suction machine.

For ditch excavation or the handling of semi-solid materials, especially in shallow waters, the dipper dredge is generally used due to its being suitable to varied service. It can be built either for marine or land operation. In the first instance the machinery and power plant are carried by a raft or barge which latter is towed to the desired point of operation. When intended for land service the construction and general method of propulsion is practically the same as for the power shovel.

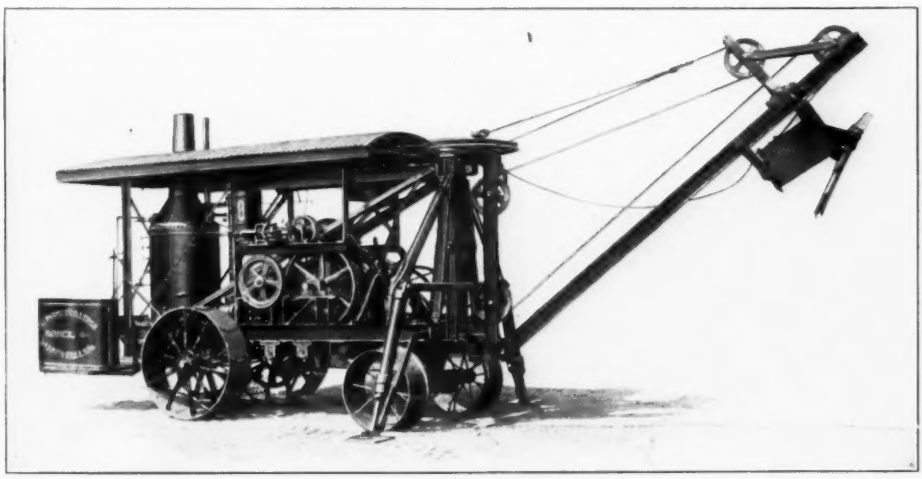
For certain types of dredging service such as are encountered in placer mining the placer type of dredge is often used. Essentially it involves a combined excavating and washing arrangement, and includes a boom-operated elevator conveyor which carries the digging buckets.

Where deep water dredging is to be done such as occurs in the construction of river embankments, dams, or the deepening of channels, etc. the hydraulic dredge is usually employed. In this equipment a suction pumping apparatus is the chief feature, operating via a boom and disposal pipe to spread the excavated material as desired.

Lubrication

Steam Cylinders

In order to keep power shovels, dredges, trenching and back filling machines in continuous operation, it is decidedly essential to give careful attention to their lubrication at all times. Perhaps the most important detail is the lubrication of steam cylinders. In any of the above machines which are steam driven, the existing conditions and methods of operation will be such that if any but a high grade, properly compounded lubricant is used, the cylinders will suffer accordingly.



Courtesy of Keystone Driller Co.

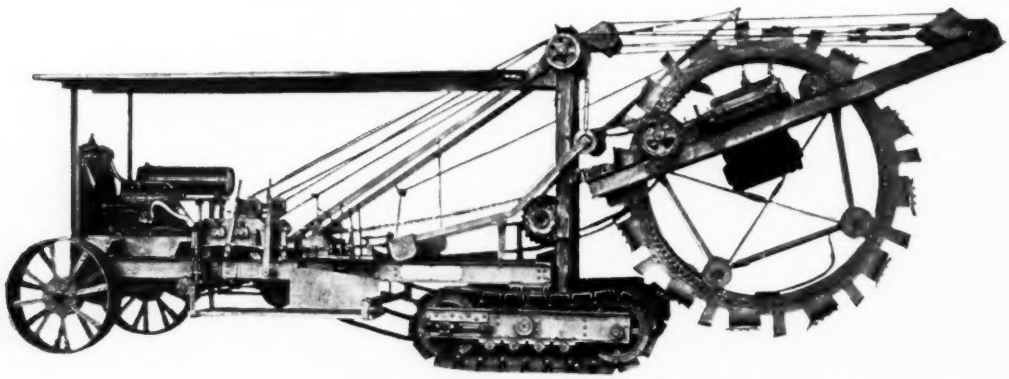
Fig. 5.—Illustration of a 6-roll Steam Skimmer Scoop, showing the mechanical details and parts which require careful lubrication, such as wire ropes, gears, and steam engine.

Steam used on such machines will, in general, be of comparatively low pressure (of from 100 to 150 lbs.) and will have quite an extensive moisture content. Although steam is taken from the highest part of the boiler, it will frequently be relatively wet when it enters the header. Furthermore, line condensation and moisture content will be high between the boiler and engines, with a corresponding decrease in pressure, due to the fact that steam pipes are often not covered to any great extent, and the engines are frequently subject to intermittent operation. As a result there will almost always be an accumulation of water above the throttle valves, prior to starting the engines, depending in amount upon the length of time they have been stopped. Now, if the cylinders are not covered with a tenacious film of properly compounded lubricant, the admission

of these slugs of water will tend to wash the lubricant from the wearing surfaces, and for the next few strokes insufficient lubrication will be possible and scoring and abnormal wear may occur. The constant repetition of the above will not take long to produce compression losses and inefficient operation of the entire machine due to steam leakage past the piston rings. Groaning of the engines or rattling of the valves on their seats may also occur in extreme cases.

It can therefore be appreciated that our problem is to select and use a grade of cylinder oil which contains a sufficient amount of high grade animal or fixed oil to promote the formation of an extremely tenacious film of emulsified lubricant, which will adequately resist the washing action of any water that may be present. The base of this lubricant should be a medium viscosity, highly adhesive, steam refined cylinder stock. For this purpose a comparatively high compound cylinder oil of about 130″ Saybolt viscosity at 210° F. has proven to be most satisfactory.

In order to efficiently lubricate such steam cylinders the oil should be delivered by a positive feed lubricator, preferably of the force feed type, via suitable atomizers. Hydrostatic lubricators could be used, were the engines to operate continually, but the usual intermittent service involved would either require constant closing and opening by the fireman or else a waste of oil would follow if the lubricator were left in service while the engines were stopped. The location of the oil pipes and atomizers in the steam lines is also important. These points should be approximately six feet back from the throttle valves. In cases where a steam thrusting engine is located on the boom in certain types of these machines, the oil line often enters the steam pipe much further back from the throttle, with the result that in event of steam leaks at the ball or swing joint there will be considerable loss of oil as well, with subsequent insufficient lubrication unless the leak is stopped.



Courtesy of Pawling & Harnischfeger Co.

Fig. 6.—A Wheel Type Trenching Machine showing general construction details. This machine is propelled and operated by an internal combustion engine.

General Lubrication

Where excavating machines, etc., are equipped with caterpillar tractors the lubrication of link-pins and rollers is also an important factor, in order to insure against excessive friction losses and power consumption. Automatic lubrication is generally regarded as the most satisfactory, the lubricant being furnished from internal reservoirs located in the treads and rollers. For this service a relatively heavy pure mineral lubricant having a viscosity of about 200″ Saybolt at 210° F. is most suitable.

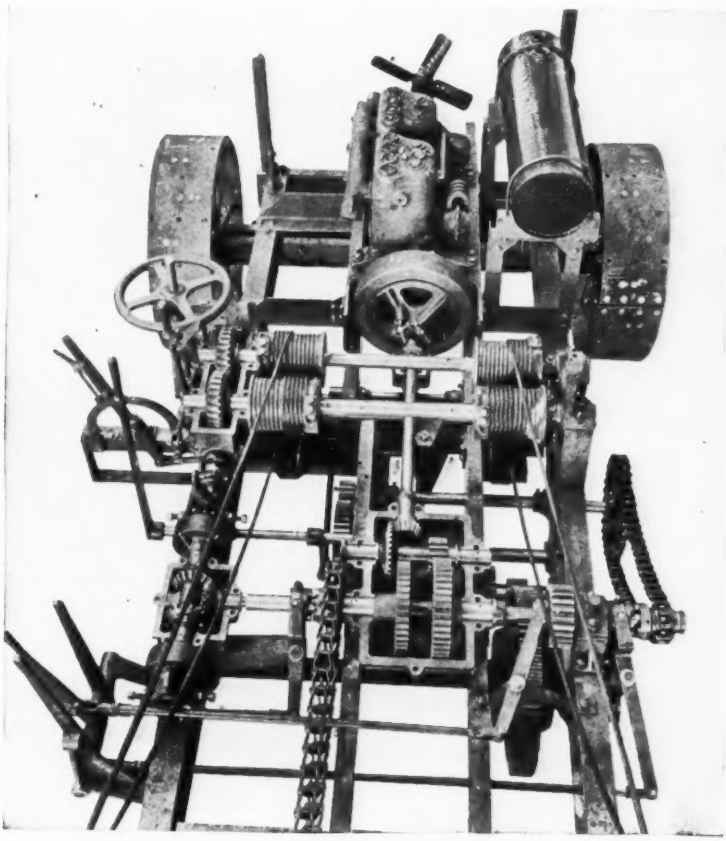
On certain types of railroad shovels and other excavating machinery, journal boxes much similar to those used in railway service is installed on traction wheel journals. As a general rule these journals, although they are not subjected to the same high speeds and lengthy periods of operation as railroad journals, are lubricated in a similar manner, i.e.,

by packing the journal box with wool waste which has been saturated in mineral oil. For this purpose a 300″ to 500″ Saybolt viscosity (at 100° F.) pure mineral oil, as recommended for general bearing service hereafter, will be suitable.

The lubrication of other wearing parts on the average excavating machine can be well taken care of by means of a medium viscosity straight mineral oil or a high grade compression cup grease. Many builders recommend grease lubrication and accordingly equip their machines with compression grease cups. Grease for this purpose should be free of acid or alkali and should contain no filler such as talc or asbestos, which would tend to clog the oil grooves. External lubrication on excavating machinery, whatever its nature, is necessarily a difficult proposition, and enough dirt, dust and abrasive matter will work its way into the bearings, without the addition of any more in the form of improperly compounded greases.

When engine bearings, etc., are lubricated with oil, the viscosity of the latter should be in the neighborhood of 300″ to 500″ Saybolt at 100° F. For electric motor bearings, however, involving ring oiling systems, a lighter oil will be best, ranging from 180″ to 200″ viscosity. The method of applying engine oils is worthy of comment.

Hand oiling is frequently customary, but is not recommended due to the possibility of oil holes becoming clogged with dust and dirt, and the bearings suffering accordingly. It has been proven that sight feed oil cups are probably the best equipment to use. They should at all times be so covered that the contents are kept free from contamination.



Courtesy of Pawling & Harnischfeger Co.

Fig. 7.—General Arrangement of Machinery on a Wheel Type Trenching Machine showing clearly the parts requiring lubrication, and their relation to each other.

In dredge operation frequently marine equipment will also be involved. The lubrication of such machinery has been discussed in considerable detail in "LUBRICATION" for February and March, 1923. In general, greater

Courtesy of Erie Steam Shovel Company

Fig. 8.—Filling Oil Reservoirs which serve to lubricate link connections of a caterpillar tractor device.

care should be observed in routine operation and lubrication due to the oftentimes more severe and exposed service to which dredges are subjected.

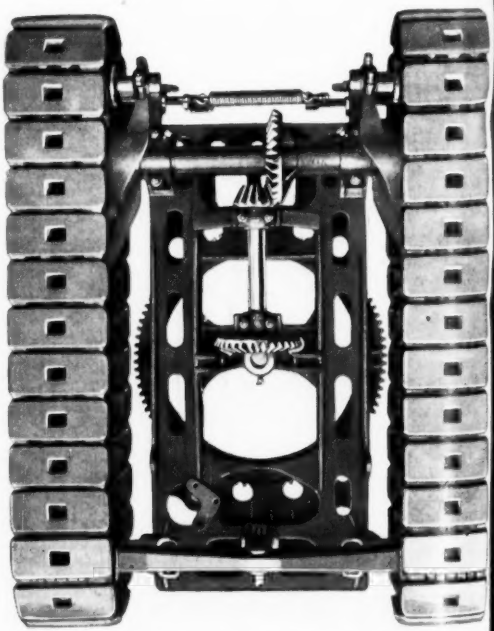
Internal Combustion Engines

Where excavating machinery, such as power shovels and trench machines, etc., are driven by kerosene or gasoline engines instead of steam, lubrication develops into a problem similar to that involved in the modern tractor or automobile. In part this has been discussed in previous issues of LUBRICATION.* For such service the motor lubricant is of chief importance and should be given careful consideration. Usually some form of force feed lubricating system is involved which passes the oil through a hollow drilled crankshaft under sufficient pressure to reach all wearing parts. On gasoline engines a straight mineral motor oil of from 500″ to 750″ Saybolt viscosity at 100° F. will be suitable, the grade selected being dependent upon the weather and operating temperatures. For tractor type engines a somewhat heavier lubricant should be used, the viscosity of which varies from 70″ to 110″ Saybolt at 210° F.

Gears, Chains and Wire Rope

In order to insure the preservation of such equipment and maintain operation at the highest state of efficiency, it is essential to keep all gear chains and wire rope well coated with a suitable compound which will serve not only as a lubricant, but also as a preservative. Wire rope in particular requires attention due to the possible hazard involved if internal strands are allowed to rust, wear and corrode. Although wire rope as constructed to-day contains a hempen core which is usually soaked in lubricant prior to the winding of the steel strands, the theory that this core will serve to adequately lubricate the strands and prevent wear, rust and corrosion during subsequent service should not be relied upon. Therefore, the exterior surface of the rope should be treated at frequent intervals with a suitable lubricant and preservative, which is capable of penetrating to the innermost strands during operation and not only re-lubricating the core but as well preventing wear at the points of contact of the strands. Such a compound should be:

1. Plastic at all temperatures.
2. Capable of being readily applied in a thin film without undue heating.
3. Free from acids and alkalis.
4. Non-evaporative.

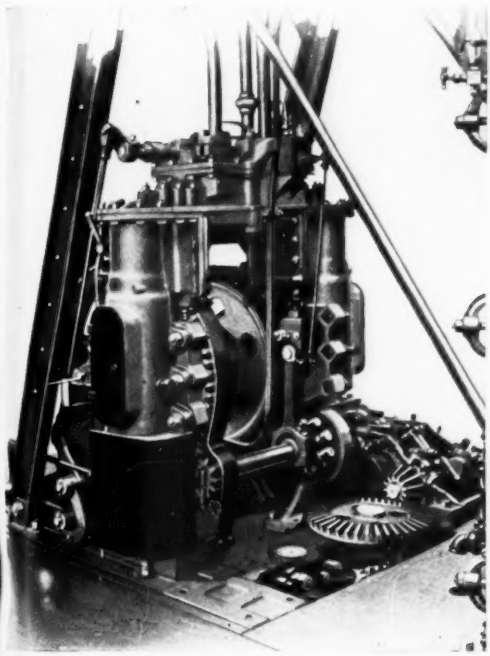


Courtesy of Erie Steam Shovel Company

Fig. 9.—Details of Construction of a Caterpillar Type Unit as viewed from underneath. Relation of gearing is clearly shown.

*See LUBRICATION for March, 1921 and January, 1923.

5. So tenacious and adhesive as to not drip or run off under abnormal pressures or temperatures.
6. Insoluble in water.
7. Non-hardening.
8. Capable of resisting the entry of dust, dirt, chemical fumes or salt water.



Courtesy of Erie Steam Shovel Company

Fig. 10.—Hoisting Engine and gearing details in a steam operated excavator.

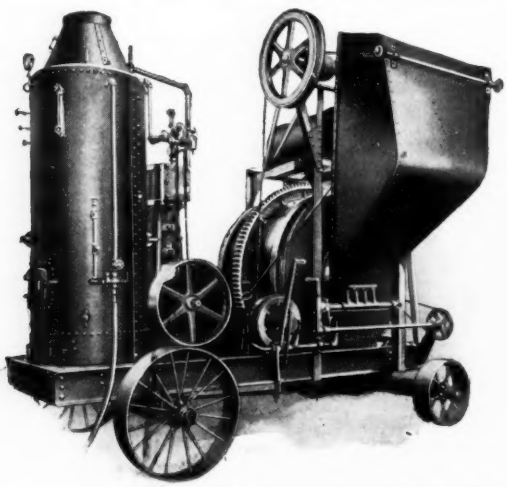
This matter of wire rope lubrication has been discussed in further detail in LUBRICATION for May, 1920. The most suitable lubricant for this service is a pure petroleum compound having a viscosity of about 1,000″ Saybolt at 210° F. Although in some cases increased viscosity up to perhaps 2,000″ may be necessary.

Gears and chains should be treated with a similar compound. There is relatively no hazard involved if they are neglected, but wear will develop abnormally accompanied by excessive noise and rattling, and corrosion of the wearing surfaces, especially if they are exposed to sea air, or acid fumes. Whatever the type of machine involved, the setting and aligning of gears is important, and all teeth should so mesh that there will be a uniform and constant application of power and smooth, quiet operation in order to insure against jerky action. This latter would tend to produce strains and abnormal wear, not only on the gears, but also on other driving mechanisms. To attain best results in applying the gear lubricant the surfaces of all teeth should first be washed with kerosene or some other solvent, the lubricant being then heated and brushed or poured lightly onto the wearing surfaces while the gears are in slow rotation. Pressure between the teeth will adequately spread the lubricant, if it is applied in the proper amount, and it should not be forced over the sides of the gears unless the film is too thick. In this event the intensity of the application should be decreased.

Concrete Mixing Machinery

IN architectural and construction work concrete mixers over the past few years have probably become the most essential mechanical equipment with which the contractor will have to deal. As a result, due to their almost universal use on practically every engineering job, their rate of concrete production is the prime factor governing the progress of the work, and possibility of break-down due to serious wearing of gears, overheated bearings or engine troubles which are traceable to faulty lubrication, should be carefully guarded against. Concrete mixers at best will receive the roughest kind of treatment, and neglect is a common factor. As well there is always a certain amount of dust grinding into bearings, gear teeth or other operating mechanisms. We can not eliminate dust, nor insure against careless workmen or the weather, but we can apply a form of practical insurance which will effectively diminish the detrimental effects of these damaging factors, by seeing to it that mixers receive proper and sufficient lubrication throughout the job.

Modern mixing of concrete and cement can be broadly divided into three methods: (1) by the use of mechanical means; (2) by gravity; and (3) by steam or air pressure. Where mechanical mixing is desired it is usually effected in some form of cylindrical or conical shaped rotating drum, box or trough-shaped container,



Courtesy of Ransome Concrete Machinery Co.

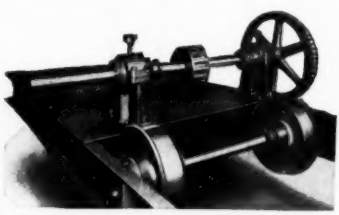
Fig. 11.—Illustration of a standard form of Concrete Mixer mounted on trucks for easy transportation, and equipped with steam engine, boiler, power loader and automatic water tank.

which is generally fitted with suitable blades or paddles to adequately mix the ingredients. The gravity mixing device eliminates machinery such as would be required for the above, and mixes the ingredients by passing them through a number of inverted cones superposed upon each other. The steam or air mixer, on the other hand, requires simply a mixing container into which the mixing agent is blown, and suitable discharge pipes leading to the moulds or point of delivery. Pressure mixing, as this latter method is termed, is used in the lining of tunnels, bridges, dams and other such structures, or the sealing of seams, the machine being built to deliver the mixture from a nozzle in the form of a jet or blast. The cement gun is an adaptation of this principle.

Mechanical mixers of the drum type with horizontal axes are probably the most extensively used by the contractor of to-day. In general principles they are all essentially alike, and involve practically the same type of mechanism being operated by either a small single cylinder vertical steam engine, an electric motor, or an internal combustion engine. The latter is chiefly used on smaller capacity mixers where the use of steam would not be convenient or economical. According to design, in general, mixers will vary as to manner of discharge, i.e., whether from the side or end; the manner of propulsion, i.e., whether stationary, self-propelled or portable; and the method of charging, i.e., by gravity, power conveyor, or hand labor. Stationary and portable mixers are chiefly used on foundation and building construction work, while self-propelled machines are favored for roadway paving, or retaining wall construction. The manner of charging and discharge is a variable which will depend in selection upon the class of work in hand. For usual service, power charging with a batch discharge from the side of the drum is probably preferable due to the steadiness of production and uniformity of concrete which are attained.

In operation concrete mixer drums are, in general, rotated by some form of gear mechanism. In usual construction one or two racks or sprocket wheels with suitable roller runways on either side of the teeth, are fitted circumferencially around the drum. The racks engage with suitable driving pinions, or the sprocket wheels with driving chains, as the case may be, which are operated directly from the power plant. Certain types of mixers have an added refinement in that they are built capable of tilting forward when discharge is desired. Tilting mixers are useful where the entire contents of the drum are to be discharged as a batch into some form of bucket or chute.

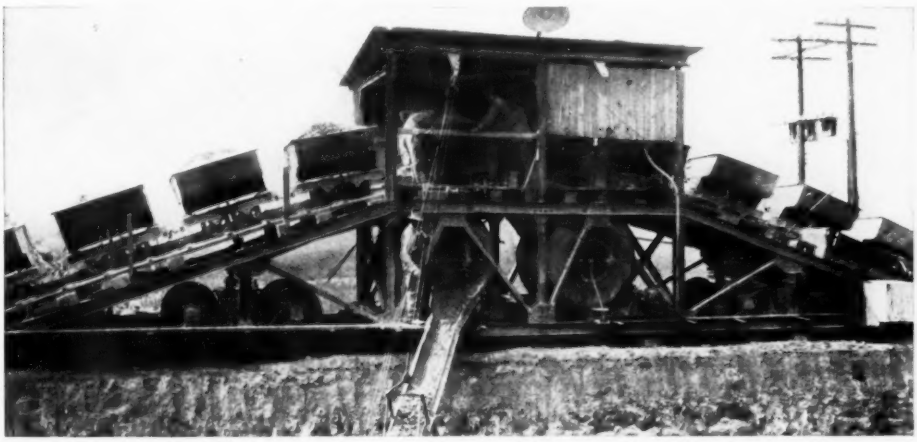
In connection with this matter of discharge the manner of placing the concrete is also of interest. Dependent upon the magnitude of the work this will either be carried out by dis-



Courtesy of Ransome Concrete Machinery Co.

Fig. 12.—Illustration of Countershaft and Rolls for drum type concrete mixer. On this equipment roller bearings are used throughout, the countershaft bearings being mounted in ball and socket hangers to insure absolute alignment and most perfect lubrication by the reduction of friction to a minimum.

charging directly into some container such as a wheel barrow, hopper, or bucket; or else a jib and bucket system may be employed, the jib being capable of swinging across the width of the work and inclining to a certain extent when necessary. The travel of the bucket on the jib is controlled as desired by wire ropes and a suitable hoisting mechanism. This



Courtesy of Koehring Company

Fig. 13.—Illustration of a chute type of Concrete Mixer showing the variety of service to which such a machine can be adapted.

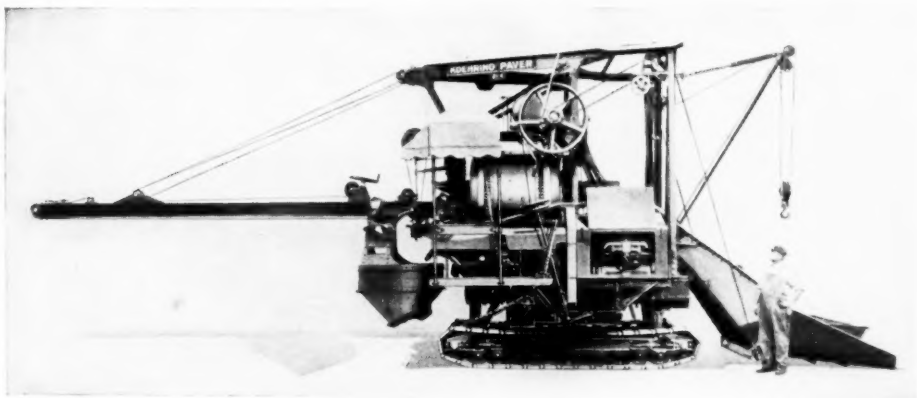
latter method is much used in street construction work. Another method is to discharge into a gravity chute or conveyor where the material is to be handled over any extensive distance.

Lubrication

In general the lubrication of concrete mixers whatever their type or design can be effectively carried out by the use of three grades of lubricants, i.e., a gear compound; a suitable grade of grease or semi-solid lubricant for general bearing lubrication, and a power plant lubricant adaptable to the type of machinery used to drive the mixer. On gears, pinions, racks, sprocket wheels and chains as well as wire rope, a heavy grade of petroleum compound having a viscosity of about 1000″ Saybolt at 210° F. has been proven to be the most dependable lubricant. Such gearing in general operates under considerable pressure and there is always a certain amount of dust, slush and water present. Therefore, we must select a lubricant that will not only have sufficient viscosity to insure a dependable film and prevent metal to metal contact, but as well which will be so adhesive as to stick to the teeth and chains and resist the washing action of water as much as possible. Grease or cylinder oils can be used on such gears but they are not as efficient as the heavier compound due to the presence of dust, and their tendency to absorb or accumulate fine particles of cement readily, and simply develop into an abrading paste instead of a lubricant. The heavier compound mentioned above, however, withstands such contamination to a marked extent.

The bearings of drum rollers also require careful lubrication if the machine is to be kept in continuous service and breakdowns forestalled. If these bearings are not properly lubricated at all times the resultant wear, which will be brought about by virtue of the abnormally high down-thrust caused by the tumbling action of the materials within the drum, will result in flattened shafts and a certain amount of wobbling. Vibration, pounding, and distortion or misalignment of the entire mechanism will thereby follow. Some manufacturers use roller bearings on the drum rolls, and certain other shafting, while others prefer split babbitted bearings equipped with grease cups. Where roller-bearings are used the most suitable lubricant will be a pure mineral product of the nature of petrolatum a relatively heavy grade of liquid grease or a

light compression cup grease. Grease cup service requires a heavier lubricant of about the same consistency as a medium compression cup grease. Attention to grease cups throughout the machine is very important. In daily operation they should be kept well filled with clean grease and screwed down at least twice a day in order to insure a sufficient film of lubricant in the bearings to prevent cement dust from working its way in along the shaft ends.



Courtesy of Koehring Company

Fig. 14.—A Concrete Mixer used for paving work, showing details of operation and construction.

Roll surfaces and drum runways should never be lubricated, inasmuch as the presence of oil or grease on the frictional surfaces will reduce tractive effort. Such rolls are in general built of car-wheel metal in order to withstand the heavy duty required.

Lubrication of the power plant of a concrete mixer will, of course, depend upon its type. Where steam is used we will have both internal (or cylinder) and external lubrication to deal with. Inasmuch as satuated steam is chiefly used, a compounded steam cylinder oil of about 130″ Saybolt viscosity at 210° F. will be suitable. This should be furnished to the cylinder at a rate of about five drops per minute by means of a dependable hydrostatic or force feed lubricator. Care of a hydrostatic lubricator is important especially in freezing weather. During such operation whenever a shutdown is to be made for any length of time, both oil and water should be drained from the lubricator, in order to prevent freezing in the sight feed glass, and possible cracking.

The external lubrication of engine bearings and guides, etc., should be carried out in a similar manner as explained heretofore, using either a high grade straight mineral oil suitable for service in ring oiling systems and drip feed oil cups, or a pure compression cup grease of light or medium grade according to the prevailing temperature involved. In general, grease lubrication is preferred by most mixer builders and their machines are therefore usually equipped with compression grease cups.

Where internal combustion engines or electric motors are used to drive the mixer, lubrication is similar to that recommended for excavating machines equipped with similar power plants. All such machinery is subjected to relatively the same severity of operation, hence, motor bearing lubricants of from 180″ to 200″ Saybolt viscosity at 100° F. will be most suitable on electric drive mixers; and the usual grades of automobile and tractor engine lubricants will serve the purpose on internal combustion engines.

Mortar and grout machinery lubrication is much similar to that of concrete mixers.

Printed in U. S. A. by
EDGAR C. RUWE CO., INC.
47 West Street, N. Y. C.